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Prediction of Electricity Load Using Artificial Neural Network for Technology Tower Block of VIT University

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Abstract

The electricity power consumption is a non-linear process and when we consider an institution like VIT University the amount of power getting consumed day by day is basically high. Also, the concerned power calculations are done by manual computation. To avoid some tedious works, we can switch to Artificial Neural Networks which have the capability to predict future data based on the data fed for training as it can recognize the pattern in it. This will in turn enable us to maintain a good power management and in the needy times we can use renewable resources of energy like wind energy or solar energy

Keywords: Neural network, data, power management, load prediction

INTRODUCTION

Load prediction is a process or technique where we will be predicting the load consumption in future. Neural Networks can be used for load prediction. This project aims at predicting the future load (in KW) consumption for the Technology Tower Block located in VIT University, using time series Artificial Neural networks and MATLAB software. The neural network was trained with the real time recorded training data. Time in hours was the input and recorded 'power consumption' in Kilowatts was the target. These data were obtained from the power-house located in VIT University and we have fed these sets into the neural net so that it is trained due to the presence of a pattern over in the long run of data set. Hence the prediction is done with less accuracy and error. Such a prediction can aid us to know about the power needed to meet the demand in the Technology Tower Block. Whenever, the load necessity is less we can then switch into renewable energy sources as mentioned above.

NEED FOR PREDICTION OF LOAD

The Prediction of Load plays an important role in implementation and analysis of the power usage in big companies and institutions. VIT University being a very big institution, the details about consumption of load will enable us effective management of power by avoiding unwanted expenses. So according to the demand and need, the load generation, partial shutdown, load switching, could be put into action so it can help in good power management.

ROLE OF ARTIFICIAL NEURAL NETWORK IN PREDICTING LOAD

The artificial neural network (ANN) just resembles like a biological neuron which consists of various processing layers and units. With the help of advanced processors, the digital processing and computation has grown high and rapid [1]. This in turn helps to handle large applications like the load prediction. The main reasons for using ANN are; they are computationally powerful; they can process the data in parallel manner; they are easily trained by observing the data patterns; they can eliminate fault with high tolerance and they are unaffected by external disturbance noises [2], [3] and [4].

TRAINING THE DATA

The Real-time training data is used in our project. We collected the voltage and current reading which has been recorded for every hour. In total, we collected for two-months from the energy meters located in the Technology Tower's power house of VIT University. From the recorded data, the power consumed in terms of Kilowatts is calculated. We have used the MATLAB software and the 2- sets of data as the training data set. The 'time' (hours) from 0 hour to 23 hours is the input. The 'power consumption' (Kilowatts) calculated is the target or output in the training data set.

Both the power consumption and time over the run say 2-months were imported to the MATLAB from our database and that data forms a pattern which can be recognized by the neural net.

METHODOLOGY

Consider the steps involved in the given flow chart,

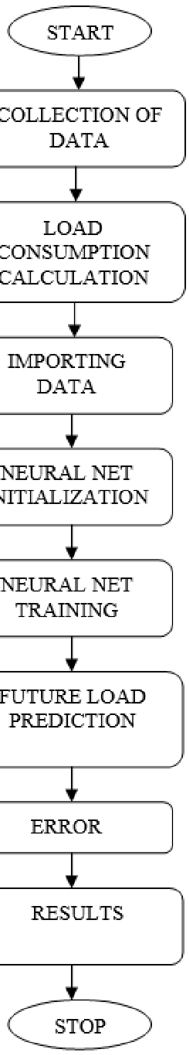

Figure 1: Process flow chart

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In this project, we have used a 'nonlinear autoregressive neural network (NARXNET) with an external input. This Network can easily learn to make predictions once a time series data of past values is given as that of a same time series pattern. So once the training data set is fed, that is the power consumption time into the neural net, the net gets trained by using the NARXNET in which we provide the size of the hidden layers, input delay and feedback delay [5]. The neural network is first trained in the open loop where there is no feedback provided. Once trained in open loop we can see the output, which is the predicted values with more errors. To turn the predictions much accurate we can train the neural net in the closed loop and by doing that we can see the output of the closed loop net that contains comparatively lesser errors. Then the NARXNET can also be used for prediction of next output, which is a time step ahead. Thus, it can help us to obtain the predicted value one-time step much. The neural net is then set to return the output at one-time step early by removing the delay. Therefore, the minimum tap delay will be now rather than 1. This net will return the same output as that of the previous net, but the output will be shifted by left for 1- time-step.

Structure of the Neural Network

There are three views for the neural network which are as follows.

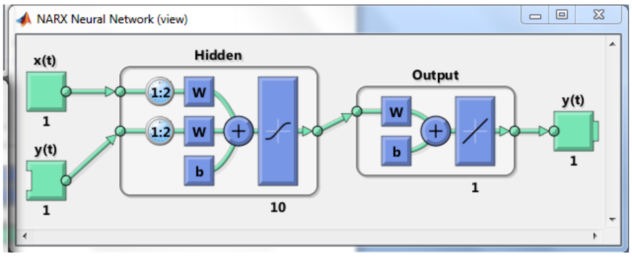

Figure 2: Open loop neural net

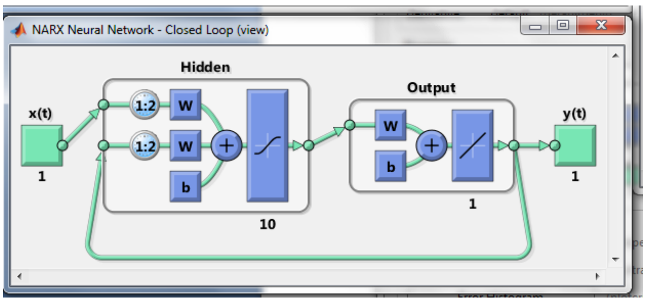

Figure 3: Closed loop neural net

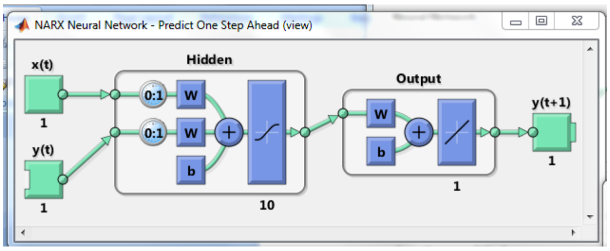

Figure 4: Early prediction net

RESULTS AND DISCUSSION

By training the neural network we can realize that the net takes some iteration before stopping the training. Once training stops the dataset can be imported for training.

Table 1: Training dataset 1

Time(Hours)	Units (Kilowatts)
0	244
1	249
2	252
3	190
4	202
5	265
6	255
7	259
8	257
9	227
10	225
11	228
12	241
13	305
14	265
15	265
16	264
17	271
18	303
19	293
20	286
21	255
22	287
23	219

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Table 1: Training dataset 2

Time(Hours)	Units (Kilowatts)
0	303
1	304
2	302
3	206
4	211
5	215
6	212
7	239
8	257
9	250
10	205
11	260
12	282
13	251
14	257
15	262
16	293
17	299
18	282
19	323
20	292
21	299
22	282
23	225

Similarly, we made computations of the power consumption for both the January and February months and all the computed and recorded readings are fed in as training data set to the neural net.

Table 3: Output data

Open loop output	Closed loop output	Early Prediction
196.50	196.50	196.50
188.28	203.50	199.28
195.16	216.91	194.13
196.60	220.52	189.60
213.45	230.63	220.11
227.35	249.63	233.38
262.38	245.06	274.30
274.30	261.07	254.03
253.03	243.68	283.94
286.94	284.44	289.77
289.66	295.62	285.78
283.78	305.39	273.38
276.38	316.03	274.41
273.41	328.05	273.81
257.81	330.10	267.13
297.13	328.95	297.80
283.80	316.43	279.39
288.39	336.08	309.60
309.50	282.70	285.52

The predicted output (power consumption in terms of Kilowatts) is shown in the tables below for a sample set.

Neural Network Performance characteristics

Let us observe the neural network performance characteristics from the plots.

1. Performance plot: The convergence occurred at 12th epoch.

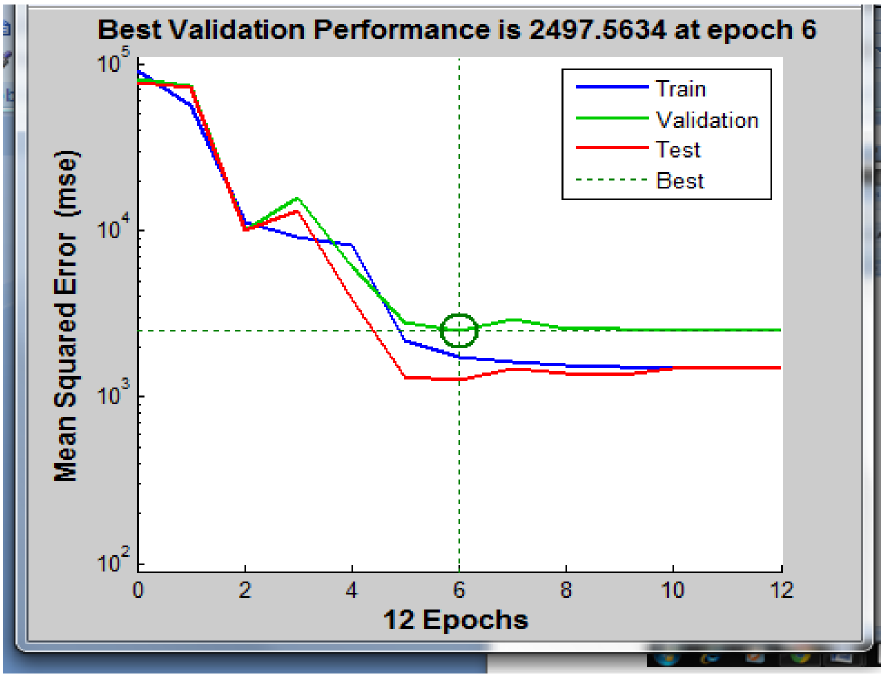

Figure 5: Performance plot

2. Training state

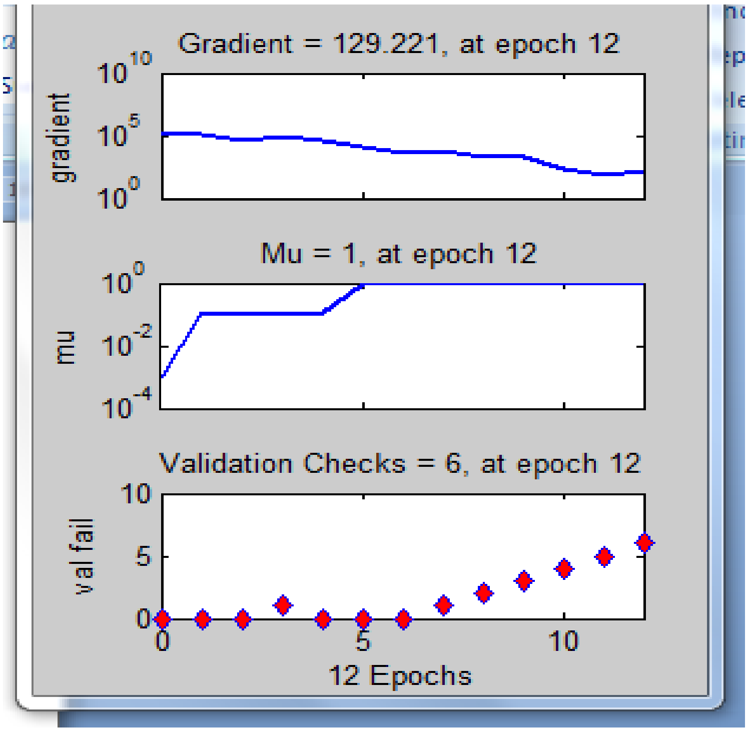

Figure 6: Training state

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3. Error Histogram

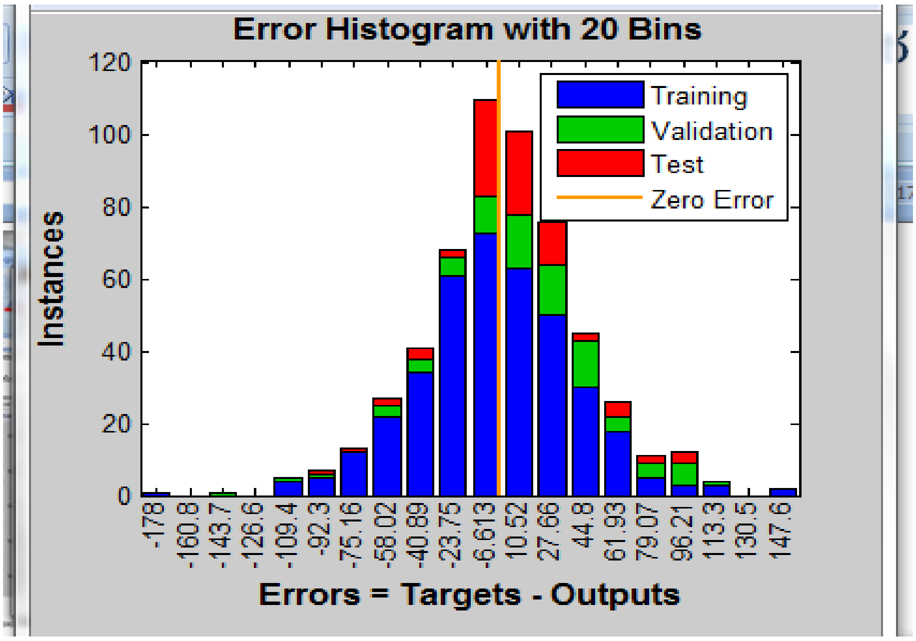


Figure 7: Error histogram

4. Error autocorrelation

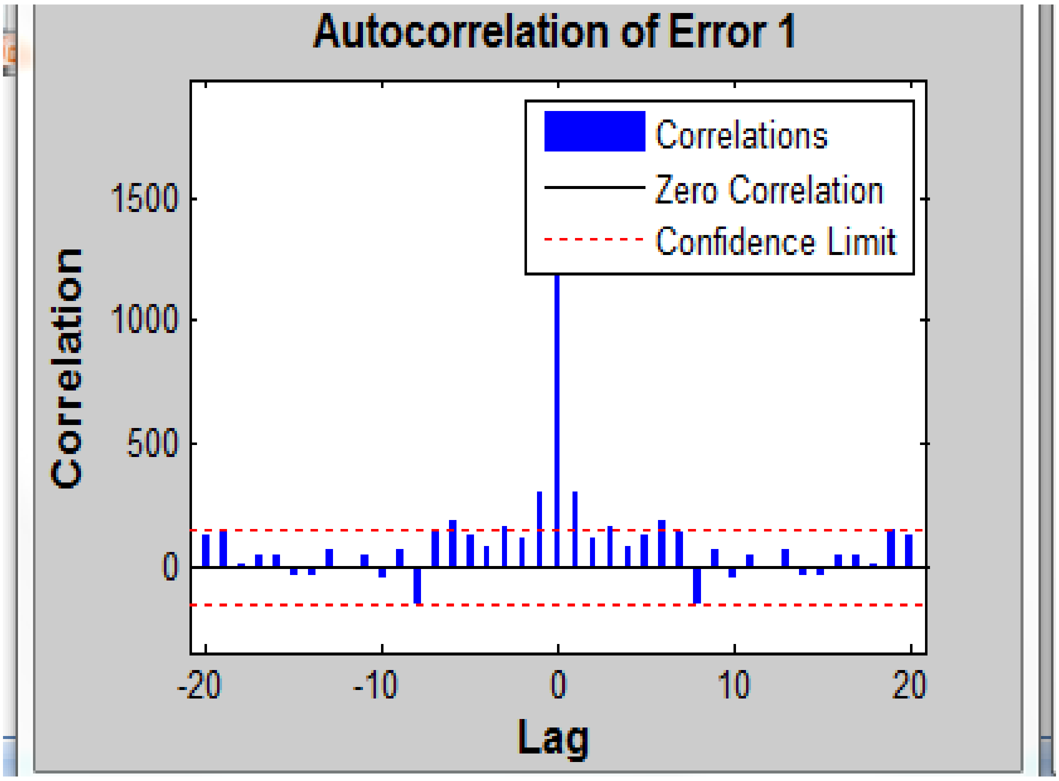
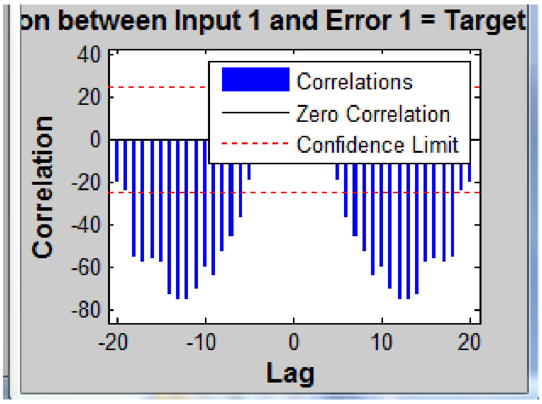


Figure 7: Error autocorrelation

5. Input-error cross correlation



6. The Error Observed

The error observed is here

[-1.50][-2.22][-35.18][-17.60][-0.49]

[3.64] [4.62][-0.38][1.96][-9.94]

[-24.60][-2.78][-0.37][-9.41][8.16]

[1.868[1.18][47.60][-8.35][7.46]

[0.16][15.05][-2.59]

Likewise, we can observe the errors for each day. As there is more training data set the accuracy of results are more.

CONCLUSION

Thus, the Neural Nets are the key and high-speed tools in for greater digital computations [6]. They possess the capability to process even several quantities of data in a tremendous speed in sophisticated applications. In such advanced applications like the electricity load prediction these neural nets have a wider scope due to their learning capabilities and hence we can make predictions of the future load with a greater accuracy. This would be much useful in implementing an effective power management system and also the effective consumption and usage of electricity by preventing wastage.

This project was put into implementation just for a short span of data set over a less period say 2months and just only for block of the VIT University. This kind of similar approach can be implemented over a large scale so that the overall institution could be involved as it helps much in the power management of the institution as mentioned in the goal.

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